

What is claimed is:

1. A method for interconnecting first and second integrated circuits, wherein the first integrated circuit is formed on a working surface of a first semiconductor substrate, the method comprising:
  - 5 forming at least one high aspect ratio hole through the first semiconductor substrate;
  - forming an optical fiber with a cladding layer and a core in the at least one high aspect ratio hole, the optical fiber having first and second ends; and
  - coupling the first integrated circuit to the second integrated circuit through the
  - 10 optical fiber.
2. The method of claim 1, and further comprising forming the second integrated circuit on a second surface, opposite the working surface of the first semiconductor substrate.
- 15 3. The method of claim 1, and further comprising:
  - forming the second integrated circuit in a working surface of a second semiconductor substrate; and
  - 20 bonding the first and second semiconductor substrates together such that the first and second integrated circuits are coupled together through the optical fiber in the first semiconductor substrate.
4. The method of claim 3, wherein bonding the first and second semiconductor substrates together comprises bonding surfaces of the first and second semiconductor substrates that are opposite the working surfaces of the first and second semiconductor substrates.
- 25 5. The method of claim 3, wherein bonding the first and second semiconductor substrates together comprises bonding a working surface of the second semiconductor

6. ~~The method of claim 1, wherein forming at least one high aspect ratio hole~~

~~forming etch pits at selected locations in the first surface of the semiconductor substrate; and~~

performing an anodic etch of the first semiconductor substrate such that high aspect ratio holes are formed through the first semiconductor substrate at the location of the etch pits.

7. The method of claim 1, wherein coupling the first integrated circuit to the second integrated circuit comprises forming optical transmitters and receivers on opposite ends of the optical fiber so as to transmit signals between the first and second integrated circuits.

8. The method of claim 7, wherein forming an optical transmitter comprises forming a gallium arsenide optical transmitter that is bonded to a surface of the first semiconductor substrate and forming an optical receiver comprises forming a silicon photodiode detector at an opposite end of the optical fiber.

9. The method of claim 1, wherein forming the optical fiber comprises forming a cladding layer of SiO<sub>2</sub>, and forming a core of polysilicon.

10. The method of claim 1, wherein forming the optical fiber comprises forming a cladding layer of  $\text{Al}_2\text{O}_3$  and forming a core of polysilicon.

11. The method of claim 1, wherein forming the optical fiber comprises forming a cladding layer of  $\text{SiO}_2$  and forming a core of  $\text{Al}_2\text{O}_3$ .

12. The method of claim 1, wherein forming the optical fiber comprises forming a core with a hole that runs substantially along the center of the optical fiber wherein the hole has a diameter that is less than 0.59 times the wavelength of the light to be transmitted in the optical fiber.
- 5 13. The method of claim 1, wherein forming the optical fiber comprises forming a cladding layer that surrounds a core layer, wherein the core layer has an index of refraction that is greater than the index of refraction of the cladding layer.
- 10 14. The method of claim 1, wherein forming the optical fiber comprises forming the cladding layer using atomic layer epitaxy.
- 15 15. An electronic system, comprising:  
at least one semiconductor wafer;  
a number of integrated circuits with at least one integrated circuit formed on the at least one semiconductor wafer;  
the at least one semiconductor wafer including at least one optical fiber formed in a high aspect ratio hole that extends through the thickness of the at least one semiconductor wafer; and  
20 at least one optical transmitter and at least one optical receiver associated with the at least one optical fiber that transmit optical signals between selected integrated circuits of the electronic system.
- 25 16. The electronic system of claim 15, wherein the number of integrated circuits includes a microprocessor and a memory device.
17. The electronic system of claim 15, wherein the number of optical fibers comprise optical fibers that are formed by an anodic etch that creates high aspect ratio holes through the semiconductor wafer that are filled with a cladding layer and a core.

18. The electronic system of claim 15, wherein each optical fiber comprises a cladding layer of  $\text{SiO}_2$  and a core of polysilicon.
19. The electronic system of claim 15, wherein each optical fiber comprises a cladding layer of  $\text{Al}_2\text{O}_3$  and a core of polysilicon.
20. The electronic system of claim 15, wherein each optical fiber comprises a cladding layer of  $\text{SiO}_2$  and a core of  $\text{Al}_2\text{O}_3$ .
21. The electronic system of claim 15, wherein each optical fiber comprises a core with a hole that runs substantially along the center of the optical fiber wherein the hole has a diameter that is less than 0.59 times the wavelength of the light to be transmitted in the optical fiber.
22. The electronic system of claim 15, wherein each optical transmitter comprises a gallium arsenide transmitter and each optical receiver comprises a silicon photodiode detector.
23. The electronic system of claim 15, wherein each optical fiber comprises a cladding layer that surrounds a core layer, wherein the core layer has an index of refraction that is greater than the index of refraction of the cladding layer.
24. An integrated circuit, comprising:
  - a functional circuit formed on a wafer;
  - a number of optical fibers formed in high aspect ratio holes that extend through the wafer; and
  - wherein the optical fibers include a cladding layer and a center core that are formed from materials with different indices of refraction.

25. The integrated circuit of claim 24, wherein the number of optical fibers comprise optical fibers that are formed by an anodic etch that creates high aspect ratio holes through the semiconductor wafer that are filled with a cladding layer and a core.
- 5 26. The integrated circuit of claim 24, wherein each optical fiber comprises a cladding layer of  $\text{SiO}_2$  and a core of doped polysilicon.
27. The integrated circuit of claim 24, wherein each optical fiber comprises a cladding layer of  $\text{Al}_2\text{O}_3$  and a core of polysilicon.
- 10 28. The integrated circuit of claim 24, wherein each optical fiber comprises a cladding layer of  $\text{SiO}_2$  and a core of  $\text{Al}_2\text{O}_3$ .
29. The integrated circuit of claim 24, wherein each optical fiber comprises a core  
15 with a hole that runs substantially along the center of the optical fiber but that has a diameter that is less than 0.59 times the wavelength of the light to be transmitted in the optical fiber.
30. The integrated circuit of claim 24, wherein the optical fiber comprises a cladding  
20 layer that surrounds a core layer, wherein the core layer has an index of refraction that is greater than the index of refraction of the cladding layer.
31. A method for forming an integrated circuit in a semiconductor wafer with an  
optical fiber that extends through the semiconductor wafer, the method comprising:  
25 forming a functional circuit in a first surface of the semiconductor wafer;  
forming a number of etch pits in the first surface of the semiconductor wafer at  
selected locations in the functional circuit;

performing an anodic etch of the semiconductor wafer such that high aspect ratio holes are formed through the semiconductor wafer from the first surface to a second, opposite surface;

forming a cladding layer of an optical fiber on an inner surface of the high aspect ratio holes;

forming a core layer of the optical fiber; and

selectively coupling the optical fiber to the functional circuit.

32. The method of claim 31, wherein forming a cladding layer comprises forming an oxide layer in the high aspect ratio holes.

33. The method of claim 31, wherein forming the core layer comprises forming a layer of an oxide with an index of refraction that is greater than the index of refraction of the cladding layer.

34. The method of claim 31, wherein forming the core layer comprises forming a layer with a hole that extends substantially along the length of the optical fiber with a diameter that is less than 0.59 times the wavelength of light used to transmit signals over the optical fiber.

35. A method for forming an optical fiber through a semiconductor substrate, the method comprising:

forming at least one high aspect ratio hole through the semiconductor substrate that passes through the semiconductor substrate from a first working surface to a surface

opposite the first working surface;

forming a cladding layer of an optical fiber on an inner surface of the at least one high aspect ratio hole; and

forming a core layer of the optical fiber.

37. The method of claim 35, wherein forming the core layer comprises forming a layer of an oxide with an index of refraction that is greater than the index of refraction of the cladding layer.

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